8.0 Traffic Light System (TLS)

8.1. Scope and Overview

This section explains the purpose and basic elements of a "Traffic Light System" (TLS), and important considerations for developing and implementing a TLS. A TLS is a combination of seismic monitoring (as discussed in Section 6) of ground motion (as discussed in Section 5) and a decision process, used as one of the tools to manage induced seismicity to acceptable levels. The risks associated with induced seismicity are also managed by injection site selection, injection well design and construction features, control over well operational factors, and even by the design of structures to withstand ground motion. As discussed in Section 4, depending on site-specific factors, different levels of ground motion can be induced or triggered by wastewater injection or hydraulic fracturing. A TLS is a tool for preventing ground motion during injection operations from exceeding levels deemed to be acceptable at a particular site. As discussed below, each State must decide what is acceptable based on their goals for managing the risks of induced seismicity.

8.2. What is a Traffic Light System?

As stated above, a TLS is a combination of seismic monitoring of ground motion and a decision process, used to manage induced seismicity to acceptable levels. The name "Traffic Light System" is based on a simplified comparison to the lights that manage automobile traffic risks by changing colors to indicate when it is safe to go (green), when caution should be exercised (yellow), and when to stop and wait until conditions are safe (red).

Some level of seismicity will be induced by Class II UIC disposal wells; induced seismicity cannot realistically be non-existent (see Section 4). The key is to control ground motion from induced seismicity such that it will not reach a level that is beyond the tolerance established by the State regulatory process. Thus, a TLS applies a decision process to real-time seismic data to determine actions and information needed to manage induced seismicity at a site. Further, an effective TLS should include a process for interaction with the injection well operator in developing site-specific actions to control seismicity, including: gathering more data, changing operational parameters (such as rates and pressures), pausing or stopping injection, and controlled re-startup (if possible).

8.3. When should a traffic light system be applied?

A TLS should be applied to those operating injection well sites where seismic monitoring has been determined to be necessary due to characteristics of the location, as explained in detail in Section 6. In addition, a TLS may be applied using data from State-wide or regional networks, but the details of this TLS may differ from one applied to a specific site.

The results from a TLS may also be useful for decisions on siting new wells in an area where the TLS has been implemented. Traffic Light Systems and seismic monitoring can also provide new information about seismicity and geologic structure that may be helpful in designing and operating new wells.

As explained in Section 3, this primer focuses on regulating induced seismicity from Class II UIC wastewater disposal wells. While the TLS discussions in this section are generally relevant,

discussion of traffic light systems for hydraulic fracturing and enhanced oil recovery operations is presented in Section 10.5.

8.4. Basic Elements of a Traffic Light System

Since the risk from induced seismicity depends on characteristics of the location and operation where injection is occurring, the TLS needs to be flexible and adaptive. The following are the basic elements of a TLS. The details of each element should be determined based on site-specific and operations-specific characteristics, for example as well-specific permit conditions.

8.4.1. Stated Goal

The general goal of a TLS is to use real-time seismic monitoring data collected during injection well operation to manage induced ground motion such that risks are acceptable. Each State must define what constitutes acceptable risk from induced seismicity. A clear statement of this goal will be the basis for the other elements of the TLS. Examples of goals for acceptable risk are:

- No damage to structures
- No seismic events that can be felt by the public
- No serious disturbance to the public ("serious disturbance" must be defined)
- No escalation to events that can be felt or cause damage

8.4.2. Seismic monitors

The decision process inherent to the TLS is based on interpretation of data on ground motion obtained from seismic monitors. Monitoring is discussed in detail in Section 6.

8.4.3. Thresholds

A TLS has" thresholds" used to guide entry into different parts of the decision process for actions that should be taken to manage induced seismicity. These thresholds are defined based on seismic monitoring data and the risk management goals of the TLS, and are typically named as colors consistent with the traffic light analogy (i.e. green, yellow and red). Note that a TLS does not have to be limited to three thresholds. The number of thresholds (lights) should be developed based on the ability to use available data to identify different levels of ground motion that warrant different types of action to ensure risk management goals are maintained. Examples of thresholds used in traffic light systems for induced seismicity are provided below in Section 8.X.

8.4.4. Decision process

A key element of a TLS is the decision process that is used to interpret seismic data and determine the best actions for managing induced ground motion and maintaining risk management goals. As explained above, a TLS applies a decision process to real-time seismic data to determine actions and information needed to manage induced seismicity at a site. This decision process should include steps for interaction with the injection well operator in developing site-specific actions to control seismicity, including:

- Gathering more data and/or more detailed analysis of data

- Changing operational parameters (such as rates and pressures) to reduce ground motion and risk
- Pausing injection
- Controlled re-startup (if possible)
- Supplemental monitoring
- Permit modification
- Stopping injection and closing well, if needed

It may be helpful to represent the general decision process, or parts of the process, in the form of a flow diagram or decision tree. Examples can be found in some of the case studies described in Section 8.X.